



Hemodialysis Dose and Adequacy

When kidneys fail, dialysis is necessary to remove waste products such as urea from the blood. By itself, urea is not very toxic, but its level represents the levels of many other waste products that build up in the blood when the kidneys fail.

To see whether dialysis is removing enough urea, the clinic should periodically—normally once a month—test a patient's blood to measure dialysis adequacy. Blood is sampled at the start of dialysis and at the end. The levels of urea in the two blood samples are then compared. Two methods are generally used to assess dialysis adequacy, URR and Kt/V.

What Is the URR?

The reduction in urea as a result of dialysis, or the URR, is one measure of how effectively a dialysis treatment removed waste products from the body. URR stands for urea reduction ratio, but it is commonly expressed as a percentage.

Example: If the initial (predialysis) urea level was 50 mg/dL and the postdialysis urea level was 15 mg/dL, the URR is computed as

$$\frac{100 \times (\text{initial level} - \text{postdialysis level})}{(\text{initial level})} =$$
$$\frac{100 \times (50 - 15)}{50} = 70\%$$

Although no fixed number can be said to represent an adequate dialysis, it has been shown that patients generally live longer and have fewer hospitalizations if the URR is at least 60 percent. For this reason, some groups advising on national standards have recommended a minimum URR of 65 percent.

The URR is usually measured only once every 12 to 14 treatments, which is once a month. It may vary considerably from treatment to treatment. For this reason, a single value below 65 percent should not be of great concern but on average the URR should exceed 65 percent.

What Is the Kt/V?

Another way of measuring dialysis adequacy is the Kt/V. In this measurement, K stands for the dialyzer clearance, expressed in milliliters per minute (mL/min), and the lowercase t stands for time. Kt, then, is clearance multiplied by time. This top part of the fraction represents the volume of fluid completely cleared of urea during a single treatment.

If the dialyzer's clearance is 300 mL/min and a dialysis session lasts for 180 minutes (3 hours), Kt will be 300 mL/min \times 180 min. This equals 54,000 mL, or 54 liters.

In the bottom part of the fraction, V is the volume of water a patient's body contains. The body is about 60 percent



Sample Dialysis Report Card

Name *Mary C.*

Name of Test	Goal	Jan	Feb	Mar	Apr
Kt/V	1.2	1.3	1.2	1.2	1.7
URR	65%	67	65	65	67
Hemoglobin	11-12	12.1	11.0	11.4	12.1
Target Weight	132 lbs	134	134	133	132

Your monthly lab tests should include either a URR or a Kt/V. Keep track of all lab results.

water by weight. If a patient weighs 70 kilograms (154 lbs), V will be 42 liters. So the ratio ($K \times t$) to V, or Kt/V, compares the amount of fluid that passes through the dialyzer with the amount of fluid in the patient's body. The Kt/V for this patient would be $54/42$, or 1.3.

The Kt/V is mathematically related to the URR and is in fact derived from it, except that the Kt/V also takes into account two additional factors: (1) urea generated by the body during dialysis and (2) the extra urea removed during dialysis along with excess fluid.

The Kt/V is more accurate than the URR in measuring how much urea is removed during dialysis, primarily because the Kt/V also considers the amount of urea removed with excess fluid. Consider two patients with the same URR and the same postdialysis weight, one with a weight loss of 1 kg during the treatment and the other with a weight loss of 3 kg. The patient who loses 3 kg will have a higher Kt/V, even though both have the same URR.

This does not mean that it is better to gain more water weight between dialysis sessions so that more fluid has to be removed, since this has bad effects on the heart and circulation. However, patients who lose more weight during dialysis will have a higher Kt/V for the same level of URR.

How Does the Kt/V Compare with the URR?

On average, a Kt/V of 1.2 is roughly equivalent to a URR of about 63 percent. For this reason, another standard of adequate dialysis is a minimum Kt/V of 1.2. This is the standard adopted by the Dialysis Outcomes Quality Initiative (DOQI) group. Like the URR, the Kt/V may vary considerably from treatment to treatment because of measurement error and other factors. So while a single low value is not always of concern, the average Kt/V should be at least 1.2. In some patients with large fluid losses during dialysis, the Kt/V can be greater than 1.2 with a URR slightly below 65 percent (in the range of 58 percent to 65 percent). In such cases, the DOQI guidelines consider the Kt/V to be the primary measure of adequacy.

Is a Kt/V of 1.2 Good Enough?

These numbers—a URR of 65 percent and a Kt/V of 1.2—have been determined to be benchmarks of dialysis adequacy on the basis of studies in large groups of patients. These studies generally showed that patients with lower Kt/V and/or URR numbers had more health problems and a greater risk of death.

One large study funded by the National Institutes of Health is testing whether a Kt/V of about 1.6 or 1.7 (and a URR of about 75 percent) results in even better patient outcomes. We should have the answer before the year 2005.

What Should You Do if Your Kt/V Is Below 1.2 or if Your URR Is Below 65 Percent?

1. If your Kt/V is always above 1.2 and your URR is close to 65 percent (it may be a few points lower if you have large fluid losses during dialysis), then your treatment is meeting adequacy guidelines.
2. If your average Kt/V (usually the average of three measurements) is consistently below 1.2, then you and your nephrologist need to discuss ways to improve it. Since the V value is fixed (it represents the total volume of water in your body), Kt/V can be improved either by increasing K (clearance) or t (session length). To increase t, you need to dialyze for a longer period. For example, if your Kt/V is 0.9 and you want to go up to 1.2, then you need $1.2/0.9 = 1.33$ times more Kt. If K is not changed, this means that the length of your session needs to increase by 33 percent. If your session lasts 3 hours, it should be increased to 4 hours.

Another way to improve the Kt in Kt/V is to increase K, the dialyzer clearance, which depends primarily on the rate of blood flow through the dialyzer. No matter how good a dialyzer you have, how well it works depends primarily on moving blood through it. In many patients, a good rate is difficult to achieve because of access problems.

If your blood flow rate is good, you can get further improvements in clearance by making sure that you use a big dialyzer or, in some cases, by increasing the flow rate for dialysis solution from the usual 500 mL/min to 600 or 800 mL/min. A good flow rate for adult patients is 350 mL/min and higher. A few centers are even using two dialyzers at the same time to increase K in large patients.

However, the rate of blood flow through the dialyzer is key, and a good vascular access is very important to make sure you are getting good clearance.

3. If during any given month your Kt/V is very low, the measurement should be repeated, unless there was an obvious reason for the low Kt/V. Obvious reasons include treatment interruption, problems with blood or solution flow, and some problem in sampling either the pre- or postdialysis blood. If there is no clear-cut reason for the sudden drop, then a problem with needle placement, like accidental needle reversal, or with the vascular access, like recirculation, should be suspected.

Hope Through Research

The National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), through its Division of Kidney, Urologic, and Hematologic Diseases, supports several programs and studies devoted to improving treatment for patients with progressive kidney disease and permanent kidney failure, including patients on hemodialysis.

- **The End-Stage Renal Disease Program** promotes research to reduce medical problems from bone, blood, nervous system, metabolic, gastrointestinal, cardiovascular, and endocrine abnormalities in kidney failure and to improve the effectiveness of dialysis and transplantation. The research focuses on reusing hemodialysis membranes and on using alternative dialyzer sterilization methods; on devising more efficient, biocompatible membranes; on refining high-flux hemodialysis; and on developing criteria for dialysis adequacy. The program also seeks to increase kidney graft and patient survival and to maximize quality of life.

- The HEMO Study is a multicenter clinical trial testing whether a higher hemodialysis dose and/or high-flux membranes will reduce patient mortality (death) and morbidity (medical problems). The full-scale phase of the trial began in July 1994 with a data center and 15 clinical sites.

- The U.S. Renal Data System (USRDS) collects, analyzes, and distributes information about kidney failure in the United States. The USRDS is funded directly by NIDDK in conjunction with the Health Care Financing Administration. The USRDS publishes an *Annual Data Report*, which characterizes the total population of people with kidney failure; reports on incidence, prevalence, mortality rates, and trends over time; and develops data on the effects of various treatment modalities. The report, available at www.usrds.org on the Internet, also helps identify problems and opportunities for more focused special research on kidney issues.

For More Information

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The National Kidney and Urologic Diseases Information Clearinghouse (NKUDIC) is a service of the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). NIDDK is part of the National Institutes of Health under the U.S. Department of Health and Human Services. Established in 1987, the clearinghouse provides information about diseases of the kidneys and urologic system to people with kidney and urologic disorders and to their families, health care professionals, and the public. NKUDIC answers inquiries; develops and distributes publications; and works closely with professional and patient organizations and Government agencies to coordinate resources about kidney and urologic diseases.

Publications produced by the clearinghouse are carefully reviewed by both NIDDK scientists and outside experts. This fact sheet was also reviewed by Dr. John Daugirdas, University of Illinois College of Medicine.

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